

Input parameters for BTA/AGS harp simulation

N particles	10000
G	1.792847
$G\gamma$	4.500000
M_{beam}	938.272000 [MeV/c ²]
Data set:	Nick's-BTA-model
Initial beam parameters at start of BTA:	
$\epsilon_{95\%x}^N$	12.000000 [μm]
$\epsilon_{95\%y}^N$	4.000000 [μm]
$\frac{\sigma_p}{p}$	0.000160
β_{x0}	4.530000 [m]
α_{x0}	0.836000
η_{x0}	1.282000 [m]
η'_{x0}	-0.581000
β_{y0}	10.982000 [m]
α_{y0}	-1.691000
AGS lattice parameters at A15:	
β_x	7.628000 [m]
α_x	1.568000
η_x	-3.405000 [m]
η'_x	0.223000
β_y	42.593000 [m]
α_y	-4.187000
q_x	0.784022
q_y	0.843957
x_{off} (horiz injection error at A15)	0.003000 [m]
Harp material parameters:	
L_{rad}	6.770000 [g/cm ²]
wire density	19.250000 [g/cm ³]
Constants for energy loss:	
Z_{wire}	74
A_{wire}	184.000000 [g/mole]
mean excitation energy	790.000000 [eV] from Ref. 2
Approximate aperture cuts for rest of AGS other than at A15:	
$\beta_{x,\text{max}}$	45.445000 [m]
$\beta_{y,\text{max}}$	72.830000 [m]
x_{cut}	0.040000 [m]
y_{cut}	0.030000 [m]

Harp parameters (units in [mm])

Harp	# wires	x diam	x wire spacing	x_{min}	x_{max}	# wires	y diam	y wire spacing	y_{min}	y_{max}
MW006	32	0.10	1.50	-24.00	24.00	32	0.10	1.50	-24.00	24.00
MW060	32	0.10	2.50	-40.00	40.00	32	0.10	2.50	-40.00	40.00
MW125	32	0.10	2.50	-40.00	40.00	32	0.10	2.50	-40.00	40.00
MW166	32	0.10	2.50	-40.00	40.00	32	0.10	2.50	-40.00	40.00
A15	64	0.10	2.00	-64.00	64.00	32	0.10	2.00	-32.00	32.00

Transport matrices between harps: From beginning of BTA to MW006:

$$\begin{pmatrix} 1.000000 & 1.251800 & 0.000000 & 0.000000 & 0.000000 & 0.000000 \\ 0.000000 & 1.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 1.000000 & 1.251800 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.000000 & 1.000000 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

From MW006 to MW060:

$$\begin{pmatrix} 5.415429 & 4.924036 & 0.000000 & 0.000000 & 0.000000 & 2.353812 \\ -0.749419 & -0.496760 & 0.000000 & 0.000000 & 0.000000 & -0.193009 \\ 0.000000 & 0.000000 & -3.554684 & 19.001910 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & -0.573749 & 2.785713 & 0.000000 & 0.000000 \\ -0.718767 & -0.218897 & 0.000000 & 0.000000 & 1.000000 & -0.435368 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

From MW060 to MW125:

$$\begin{pmatrix} 3.315529 & 17.914047 & 0.000000 & 0.000000 & 0.000000 & 0.203545 \\ 0.035413 & 0.492949 & 0.000000 & 0.000000 & 0.000000 & 0.015563 \\ 0.000000 & 0.000000 & -1.318182 & 5.794729 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.023651 & -0.862588 & 0.000000 & 0.000000 \\ -0.044390 & -0.178454 & 0.000000 & 0.000000 & 1.000000 & -0.000020 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

From MW125 to MW166:

$$\begin{pmatrix} 1.051199 & 9.952291 & 0.000000 & 0.000000 & 0.000000 & 0.000000 \\ 0.141458 & 2.290556 & 0.000000 & 0.000000 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.389916 & 12.420484 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & -0.135632 & -1.755804 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 & 0.000003 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

From MW166 to A15:

$$\begin{pmatrix} 0.410263 & -8.632307 & 0.000000 & 0.000000 & 0.000000 & -2.076254 \\ 0.109794 & 0.127538 & 0.000000 & 0.000000 & -0.000000 & -0.068879 \\ 0.000000 & 0.000000 & -3.582099 & -26.543644 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & -0.120213 & -1.169949 & 0.000000 & 0.000000 \\ -0.200072 & -0.865965 & 0.000000 & 0.000000 & 1.000000 & -0.342005 \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

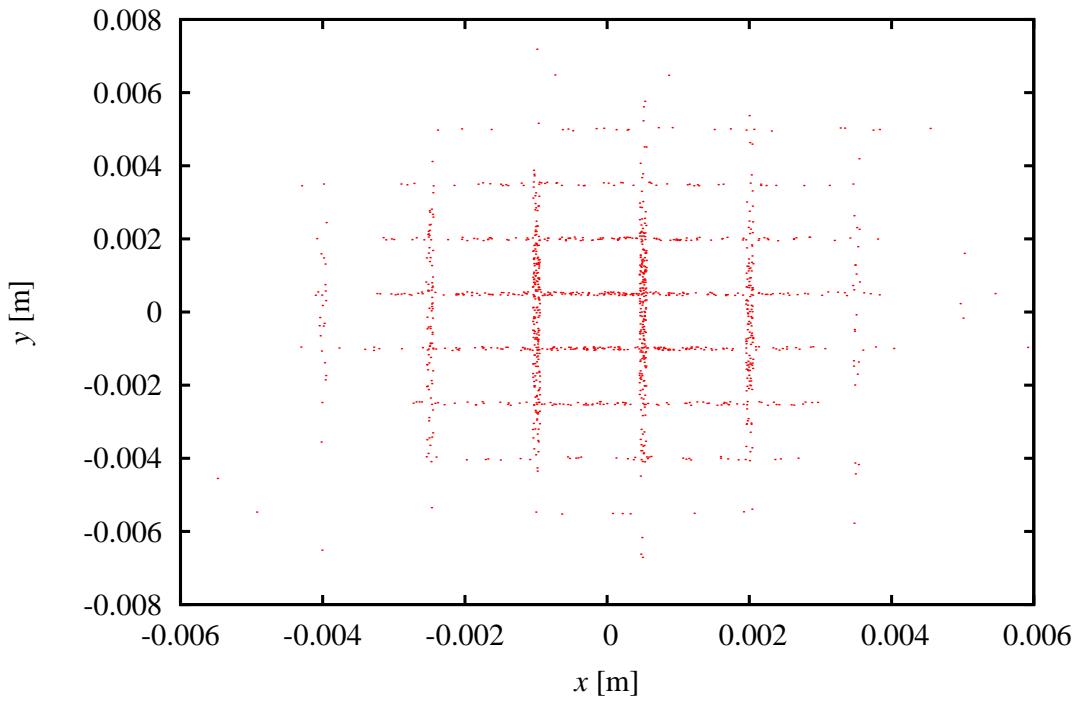
AGS one-turn matrix at A15 harp:

$$\begin{pmatrix} -1.320168 & -7.454378 & 0.000000 & 0.000000 & 0.000000 & -6.237847 \\ 0.443091 & 1.744453 & 0.000000 & 0.000000 & 0.000000 & 2.119713 \\ 0.000000 & 0.000000 & 4.034986 & -35.383978 & 0.000000 & 0.000000 \\ 0.000000 & 0.000000 & 0.361433 & -2.921684 & 0.000000 & 0.000000 \\ — & — & 0.000000 & 0.000000 & 1.000000 & — \\ 0.000000 & 0.000000 & 0.000000 & 0.000000 & 0.000000 & 1.000000 \end{pmatrix}$$

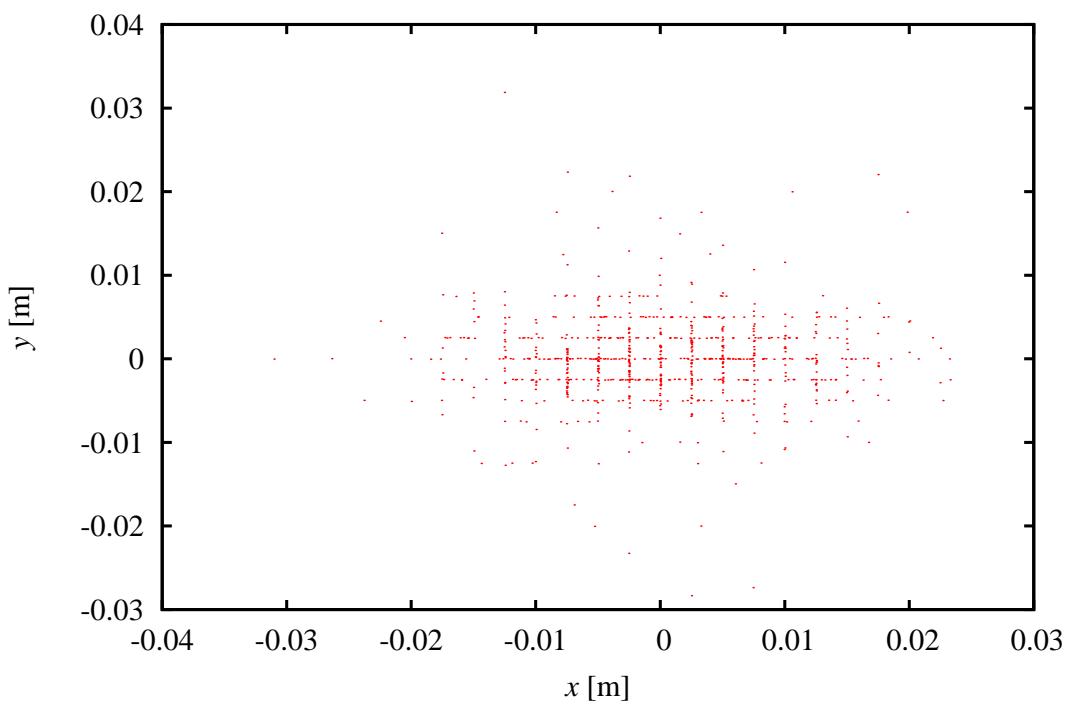
References

1. W. R. Leo, **Techniques for Nuclear and Particle Physics Experiments** Springer-Verlag (1987).
2. <http://www.srim.org/SRIM/SRIMPICS/IONIZ.htm>
3. <http://pdg.lbl.gov/>

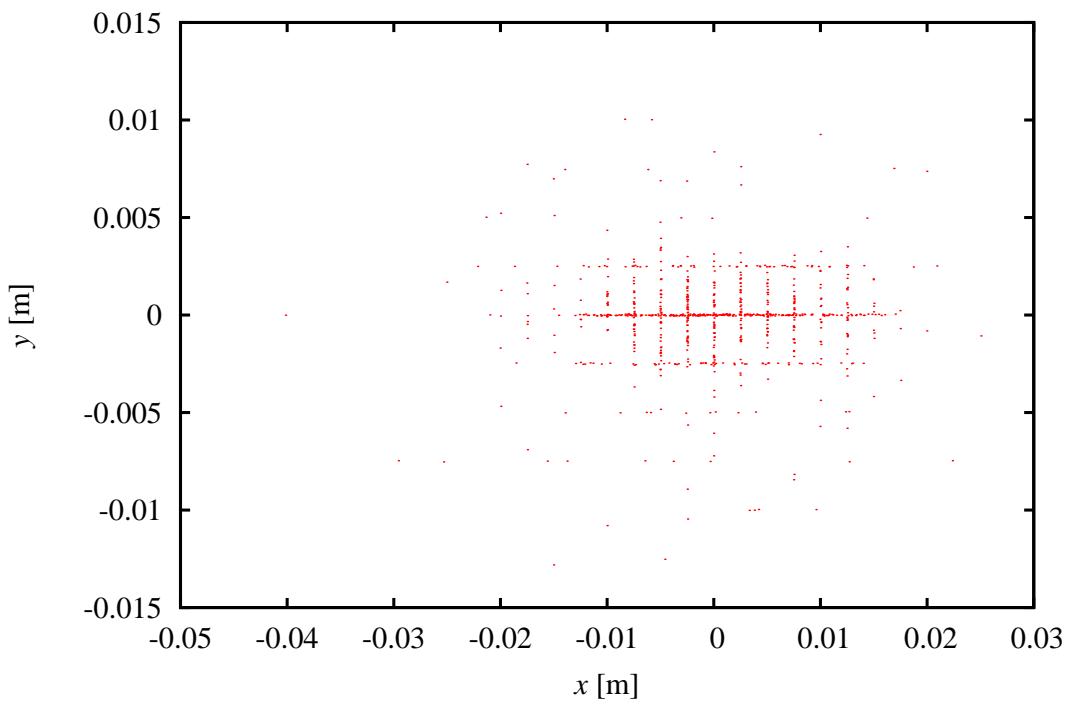
Waffle pattern of hits on wires of MW006



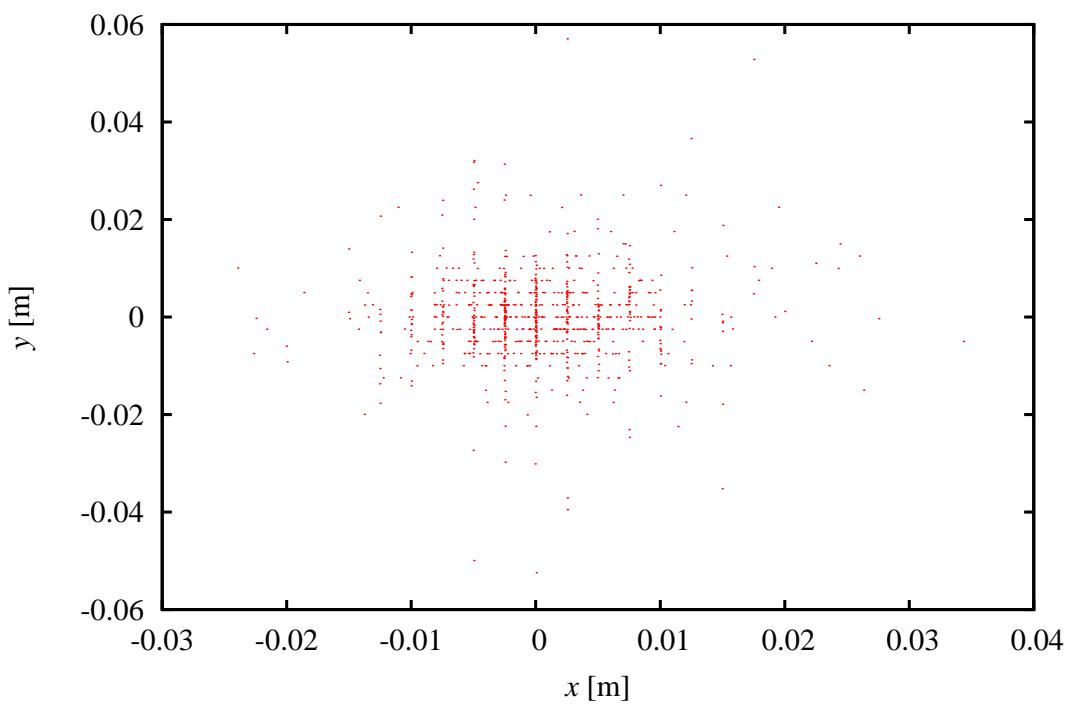
Waffle pattern of hits on wires of MW060



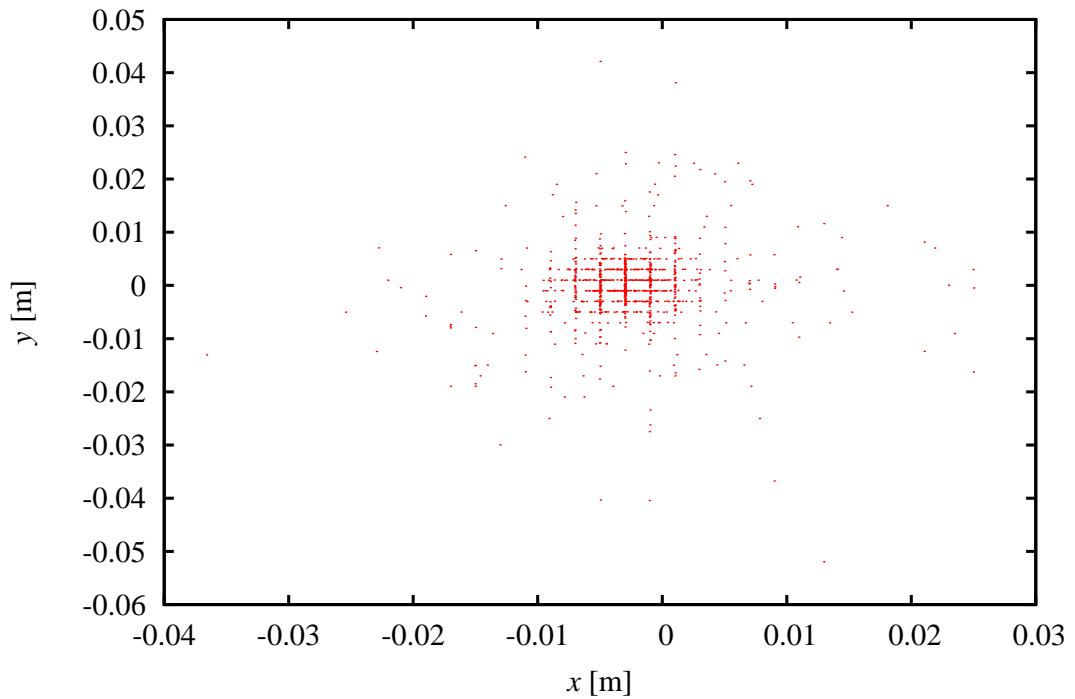
Waffle pattern of hits on wires of MW125



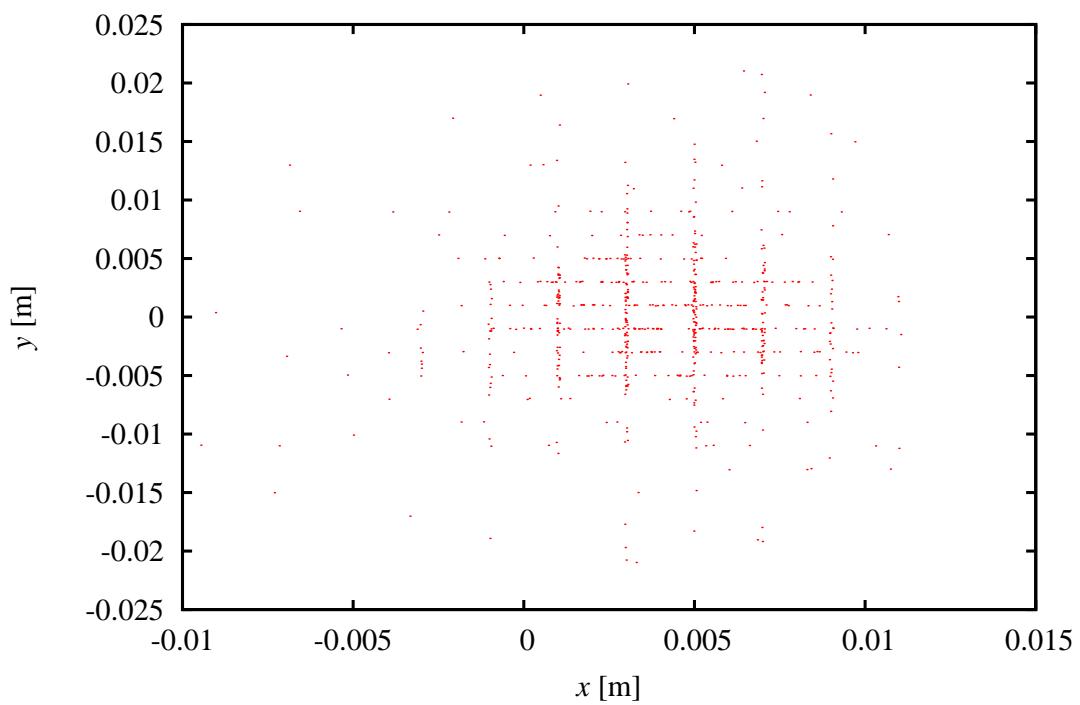
Waffle pattern of hits on wires of MW166



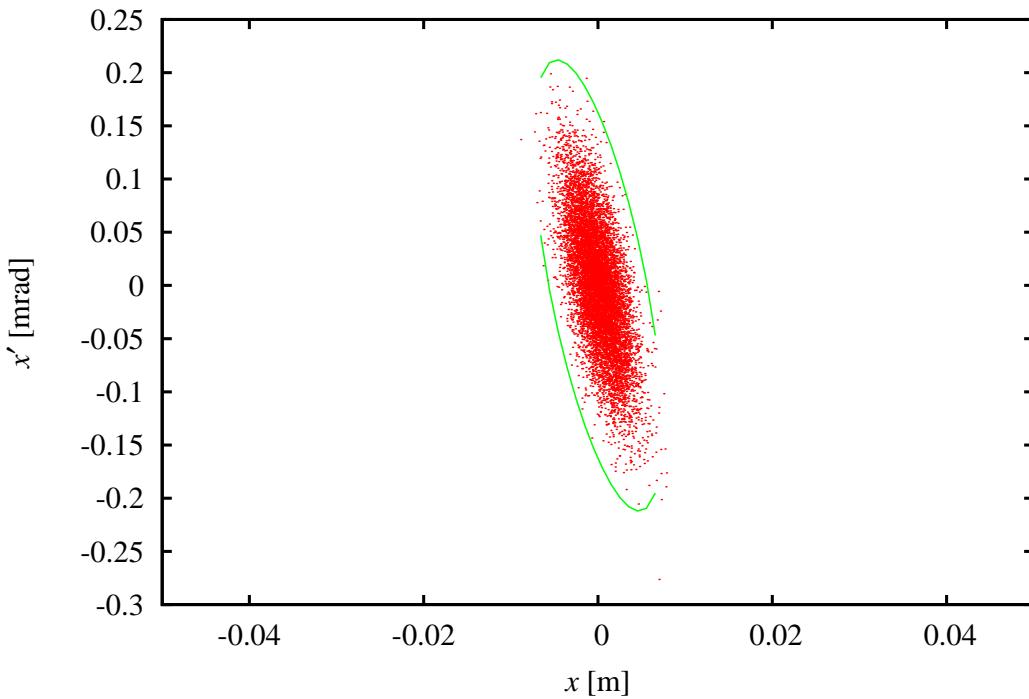
Waffle pattern of hits on wires of A15harp turn 0



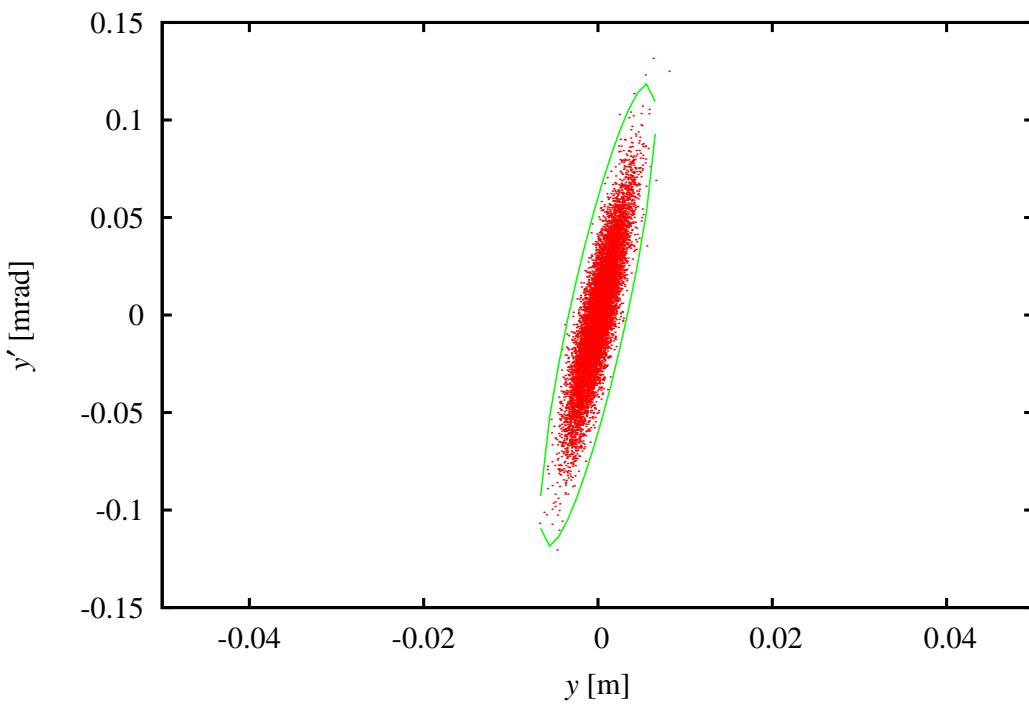
Waffle pattern of hits on wires of A15harp turn 1



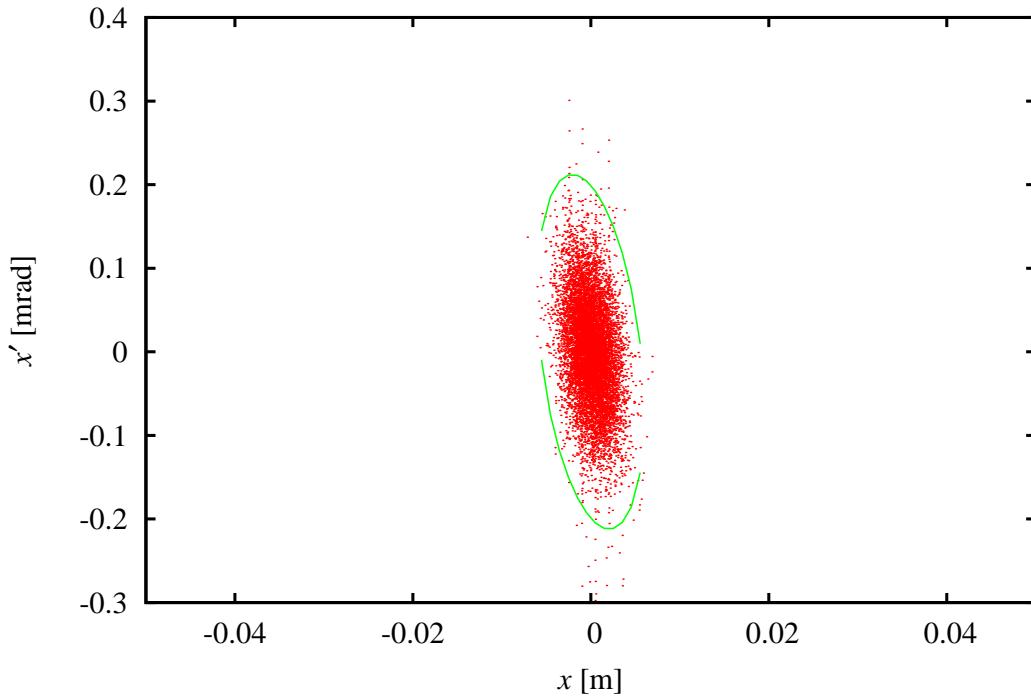
Initial phase space distribution



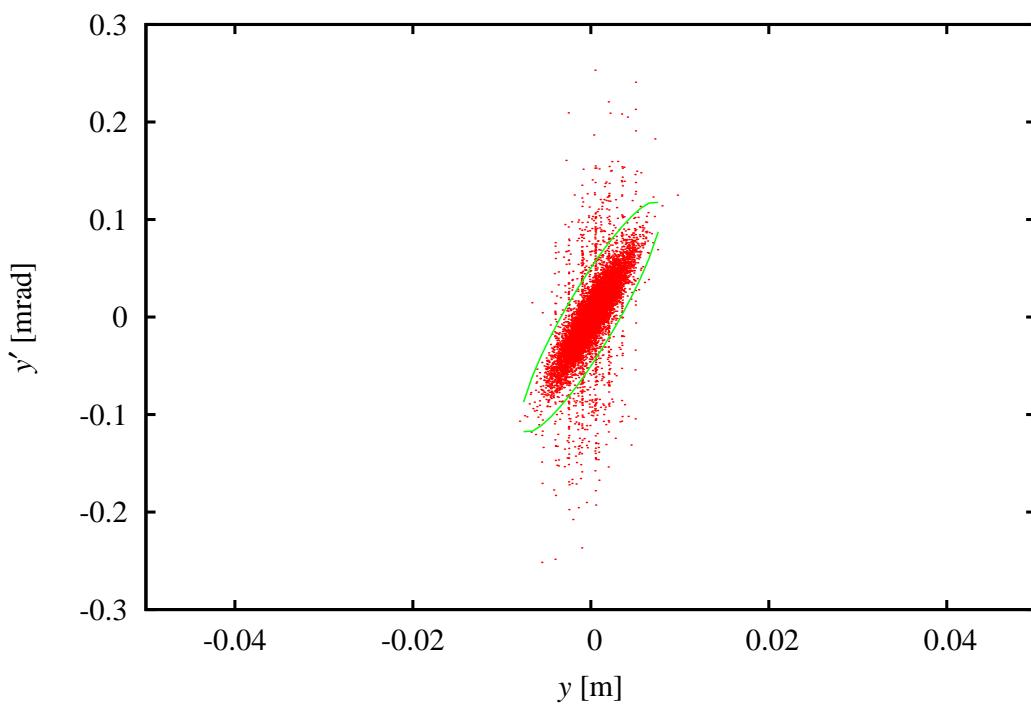
Initial phase space distribution



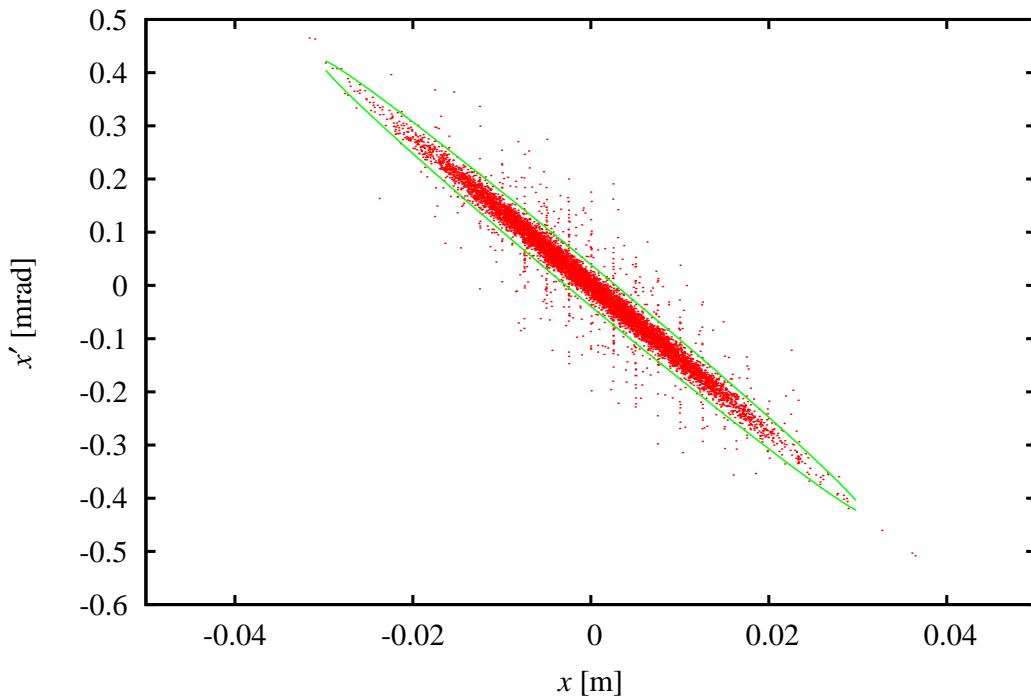
Phase space distribution after harp MW006



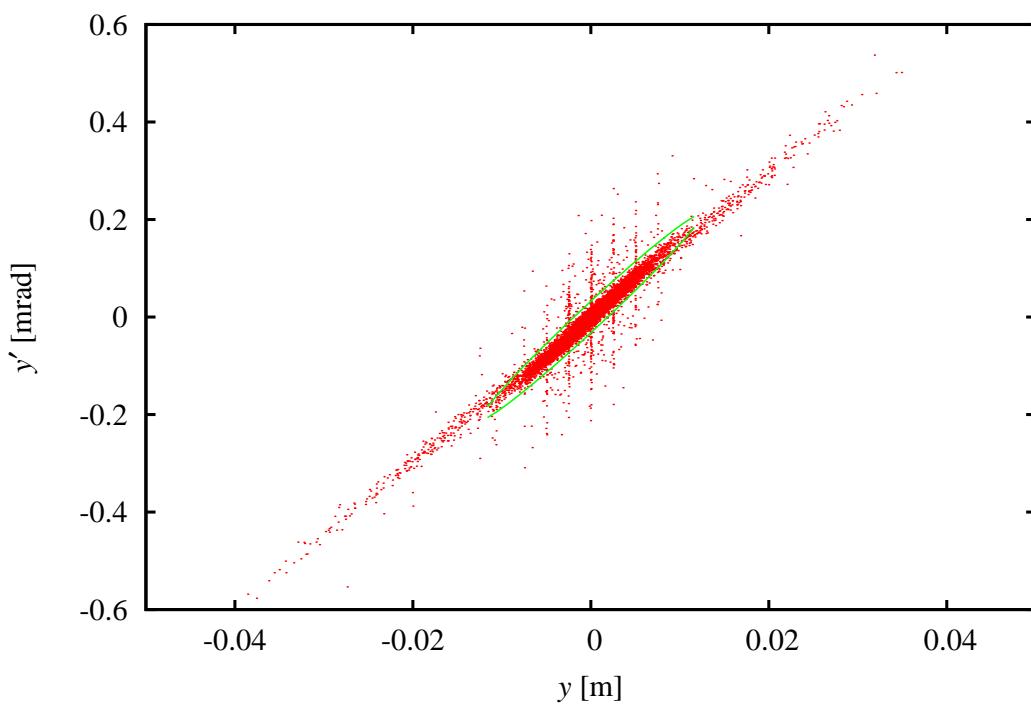
Phase space distribution after harp MW006



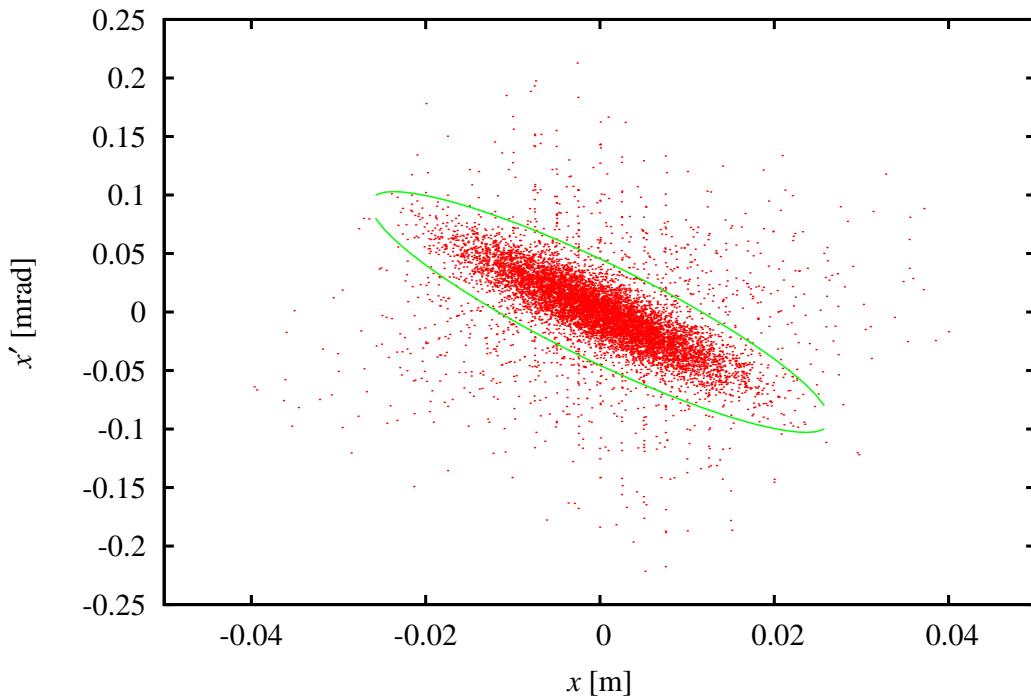
Phase space distribution after harp MW060



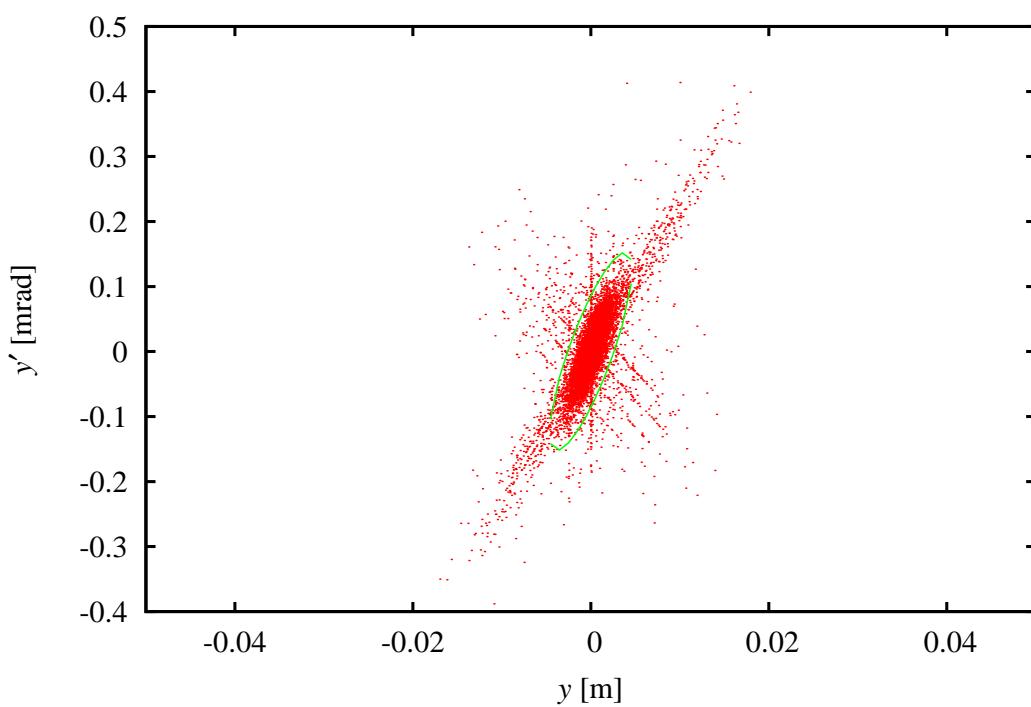
Phase space distribution after harp MW060



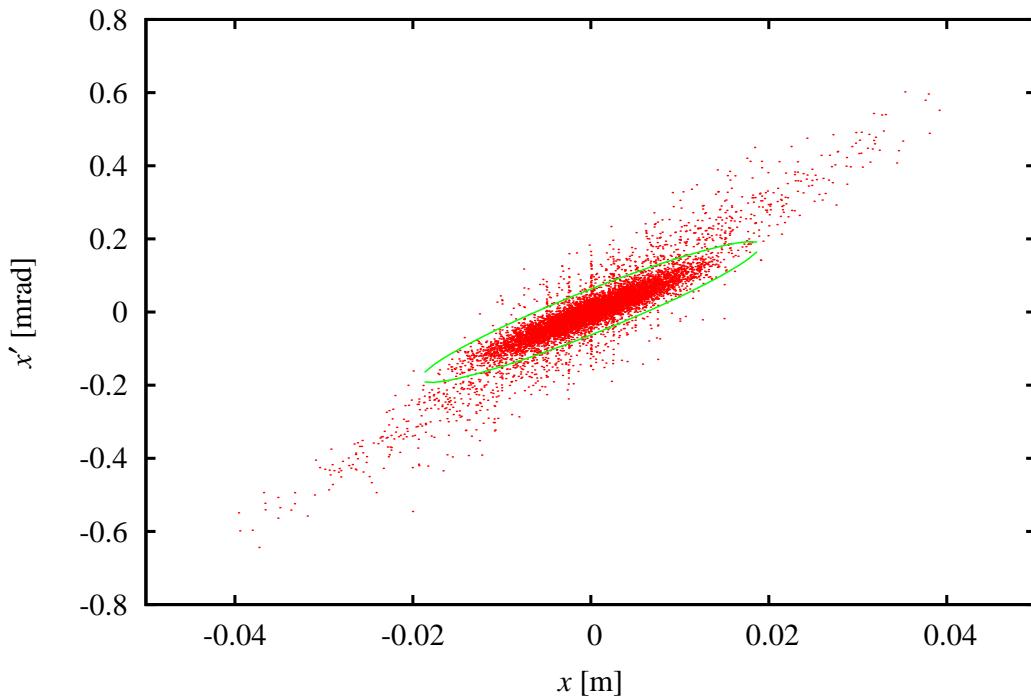
Phase space distribution after harp MW125



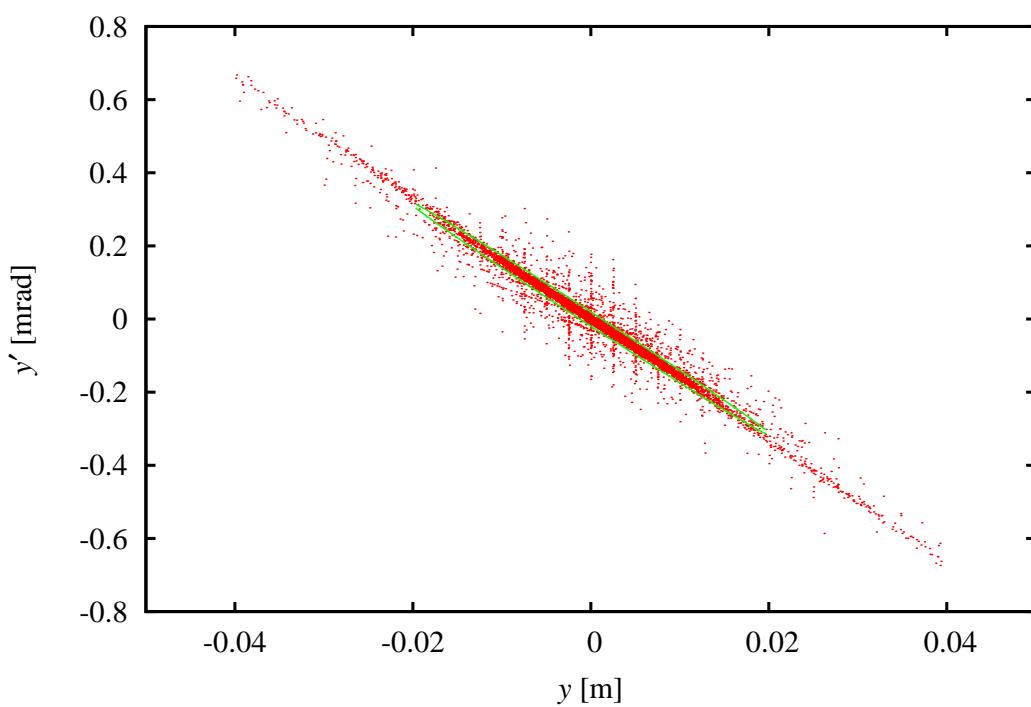
Phase space distribution after harp MW125



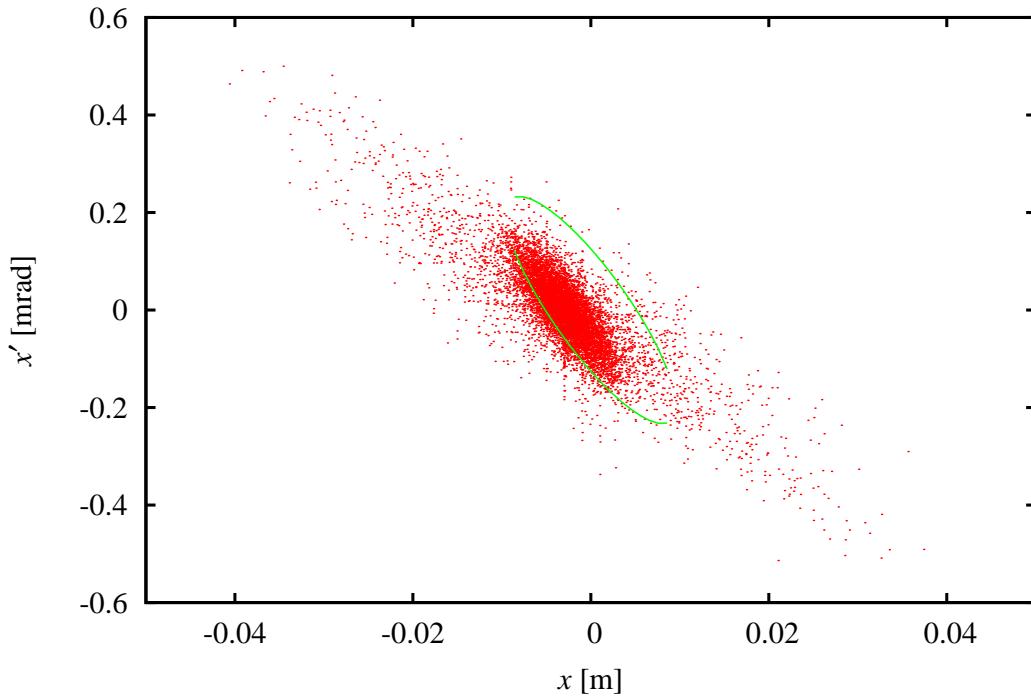
Phase space distribution after harp MW166



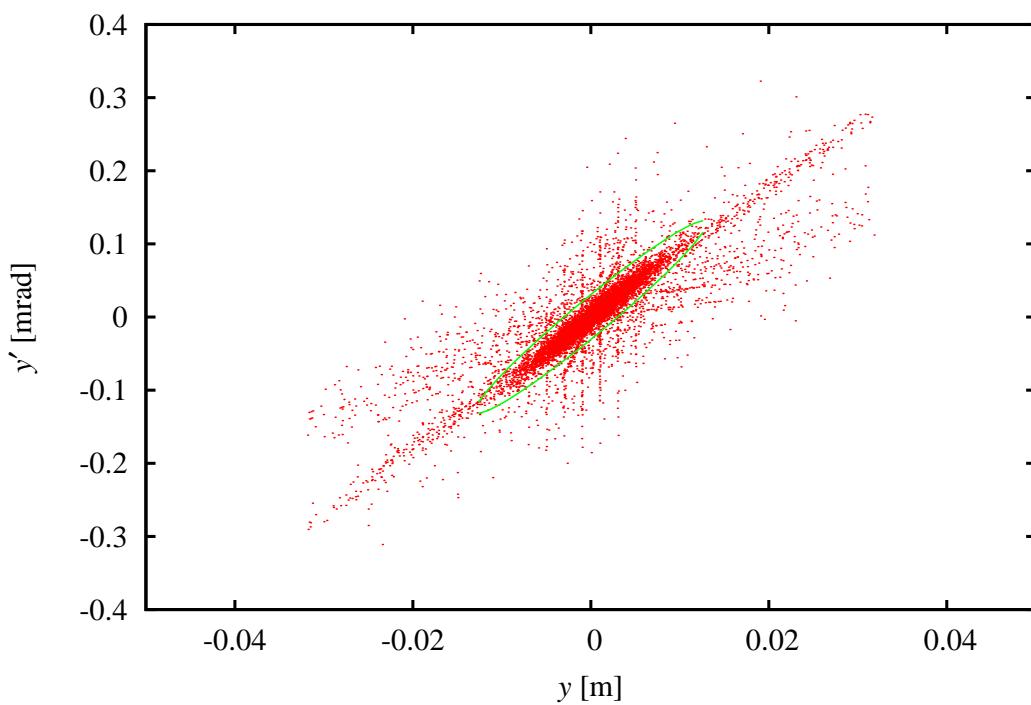
Phase space distribution after harp MW166



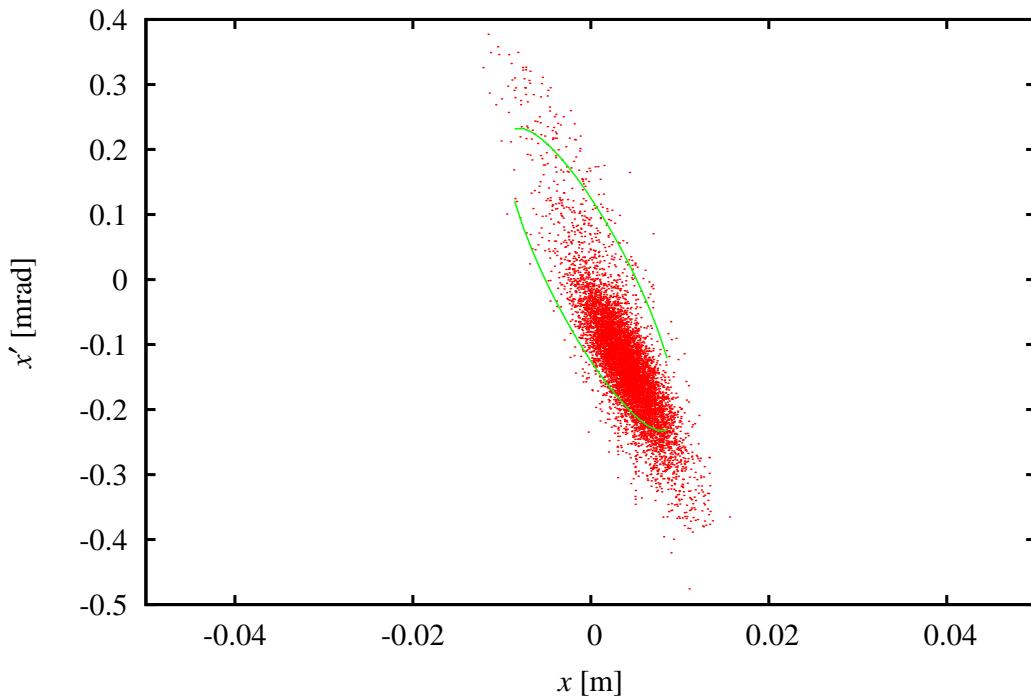
Phase space distribution after A15 harp turn 0



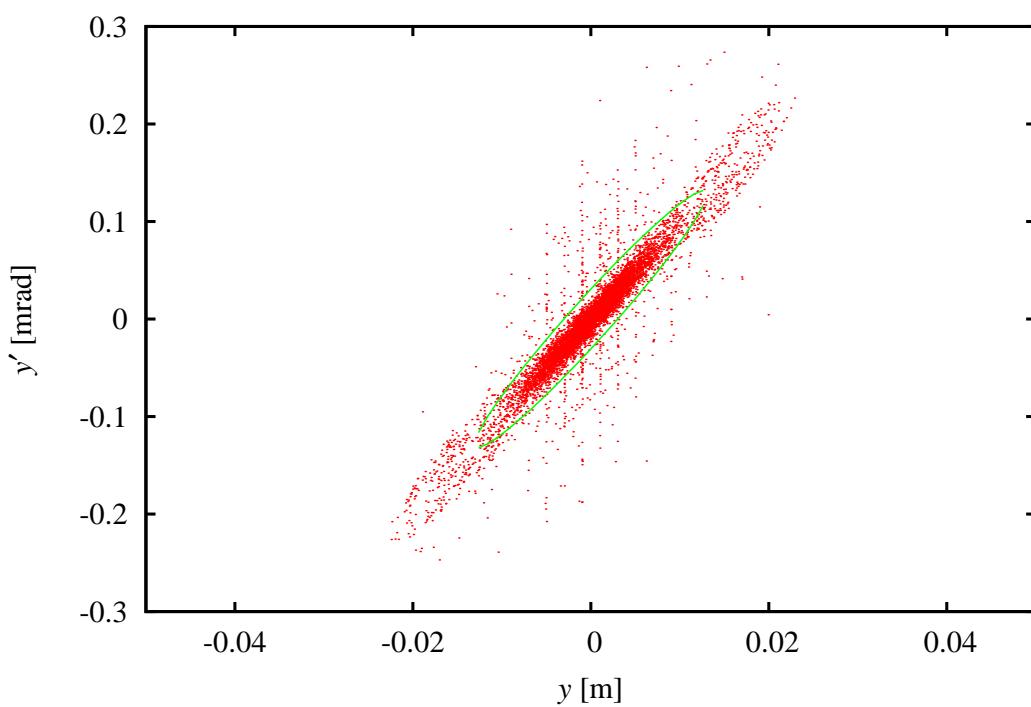
Phase space distribution after A15 harp turn 0

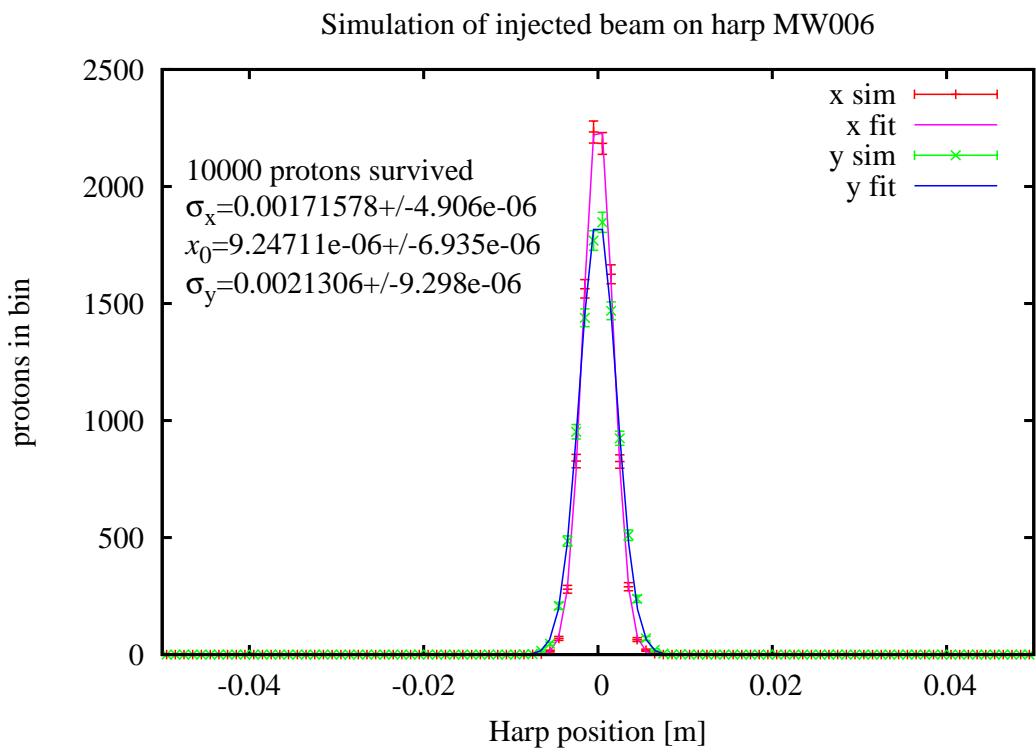
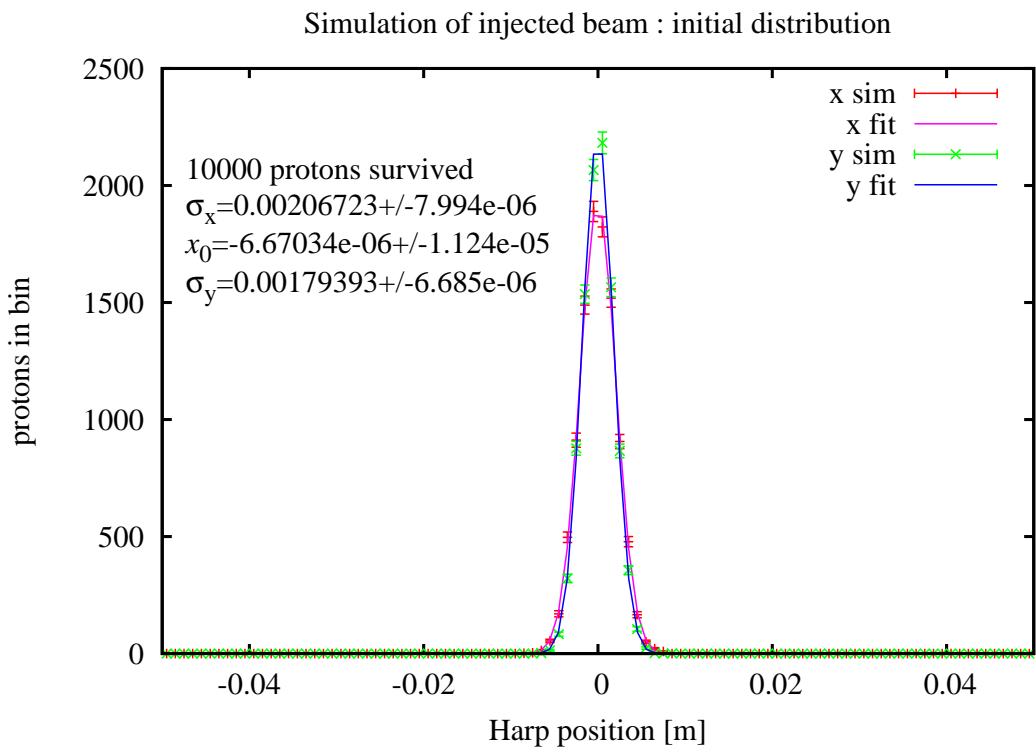


Phase space distribution after A15 harp turn 1

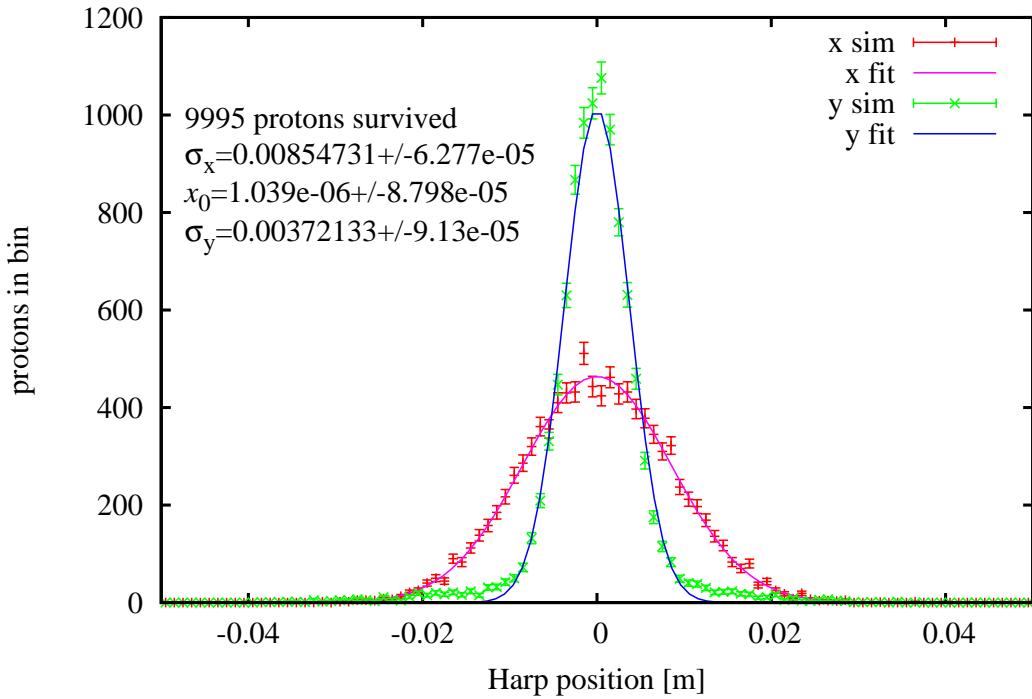


Phase space distribution after A15 harp turn 1

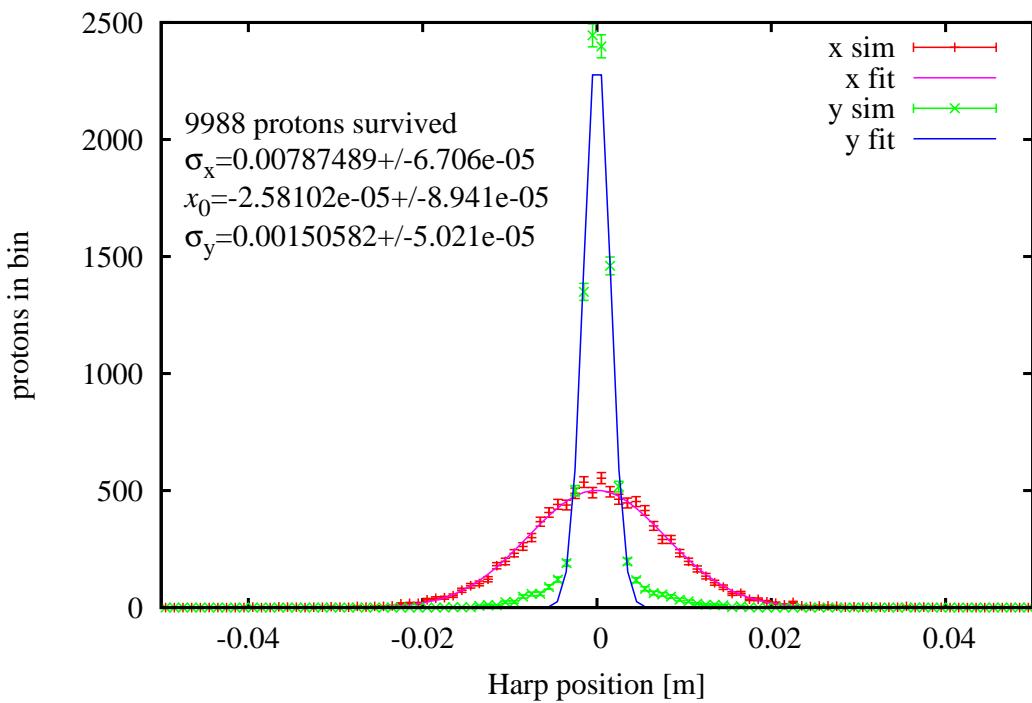




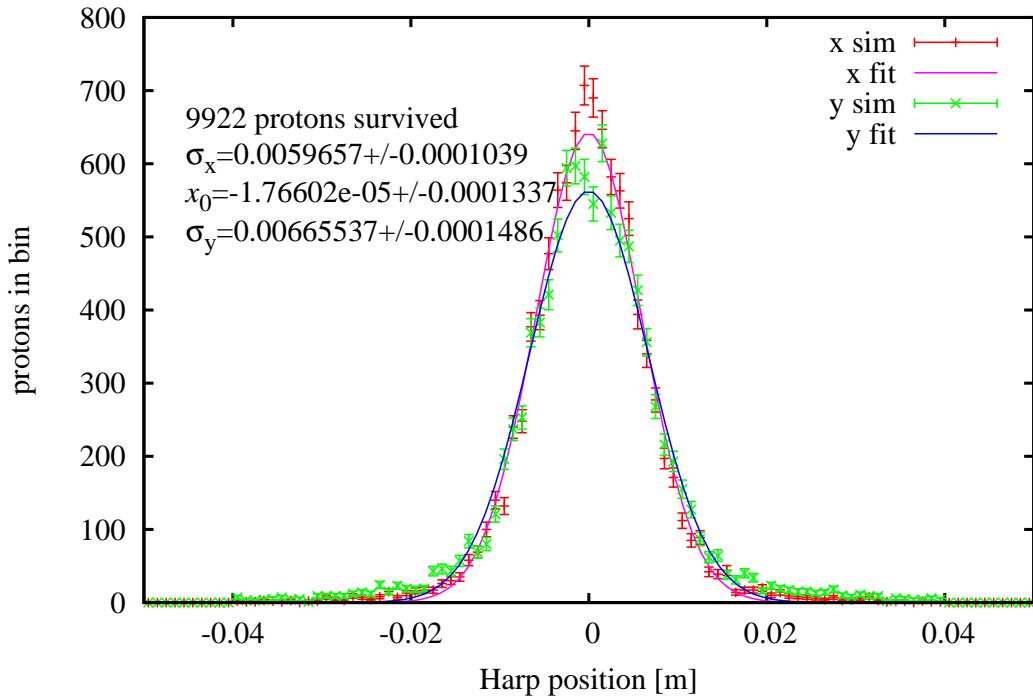
Simulation of injected beam on harp MW060



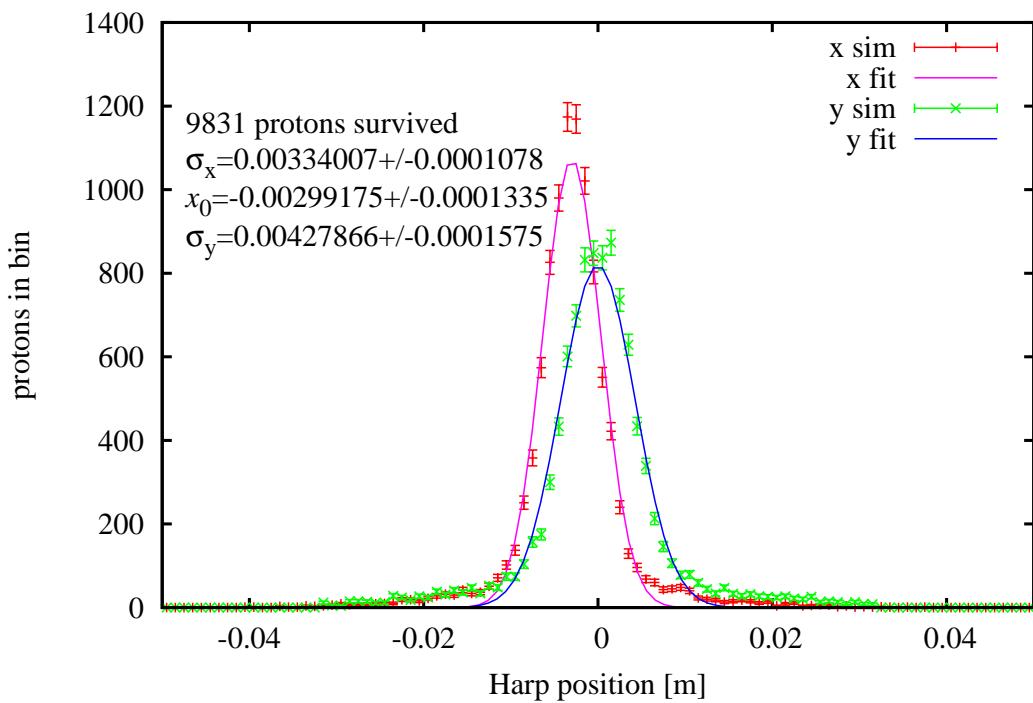
Simulation of injected beam on harp MW125



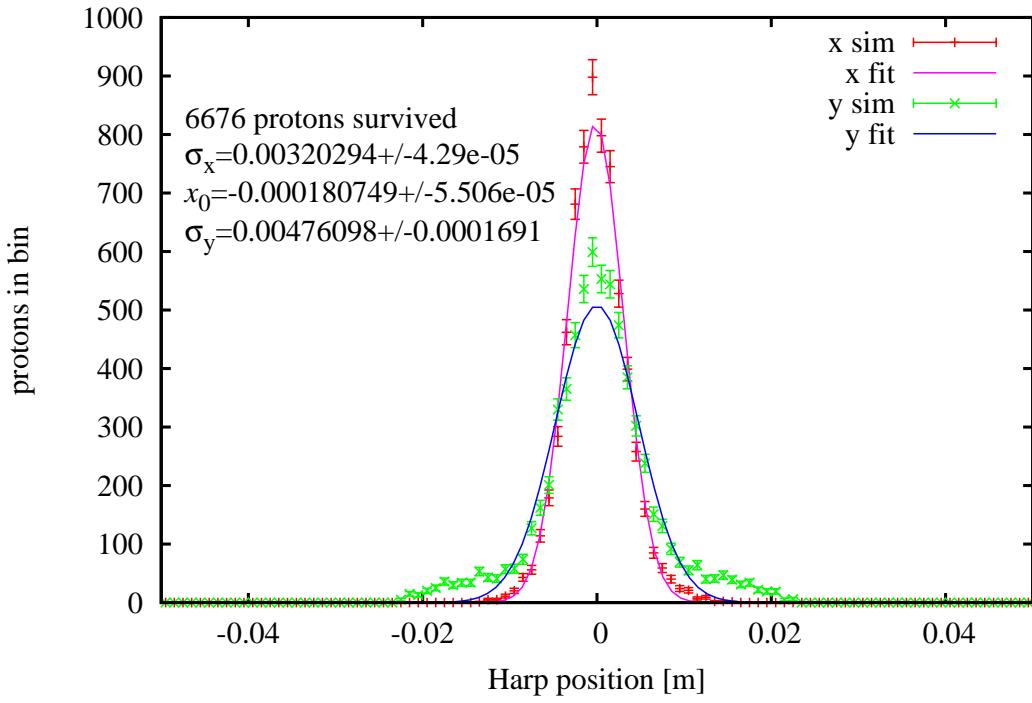
Simulation of injected beam on harp MW166



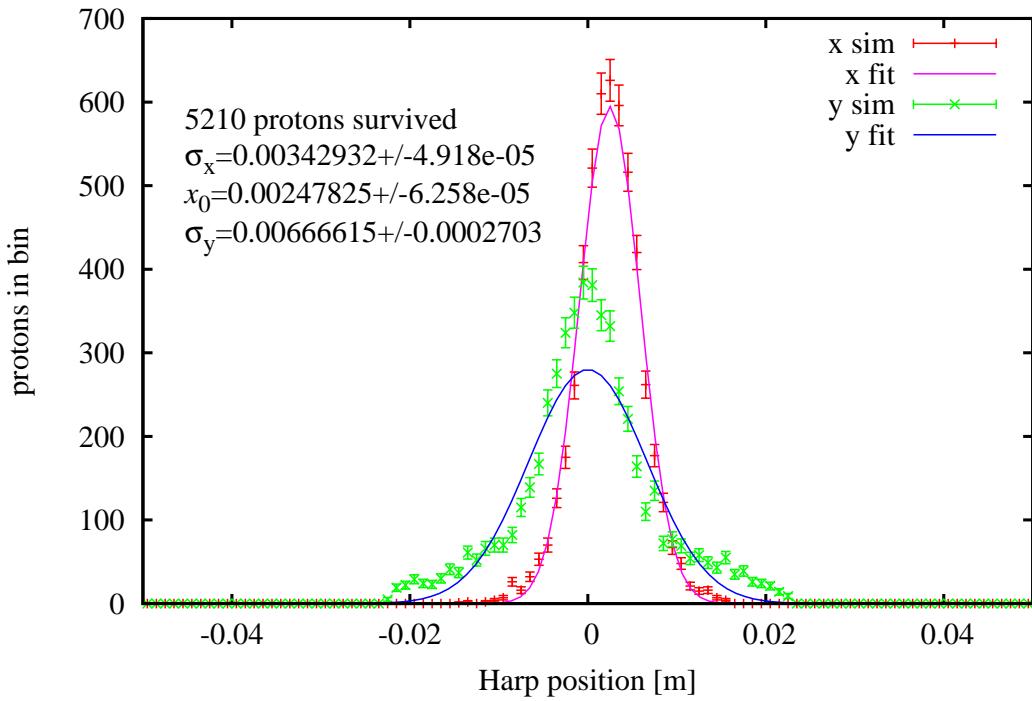
Simulation of injected beam on A15 harp turn 0



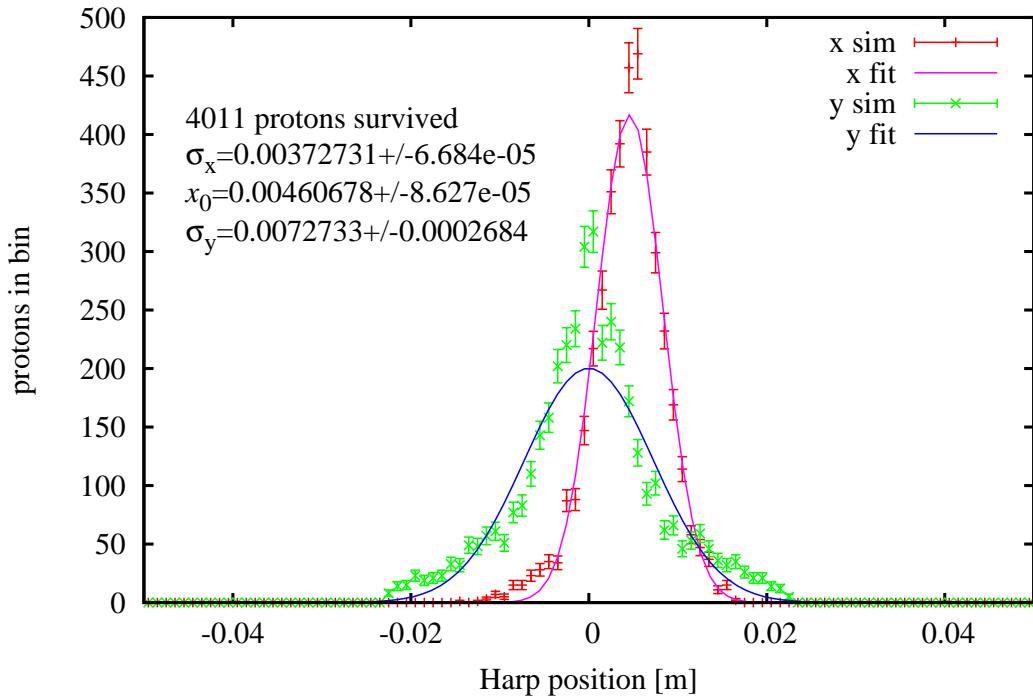
Simulation of injected beam on A15 harp turn 5



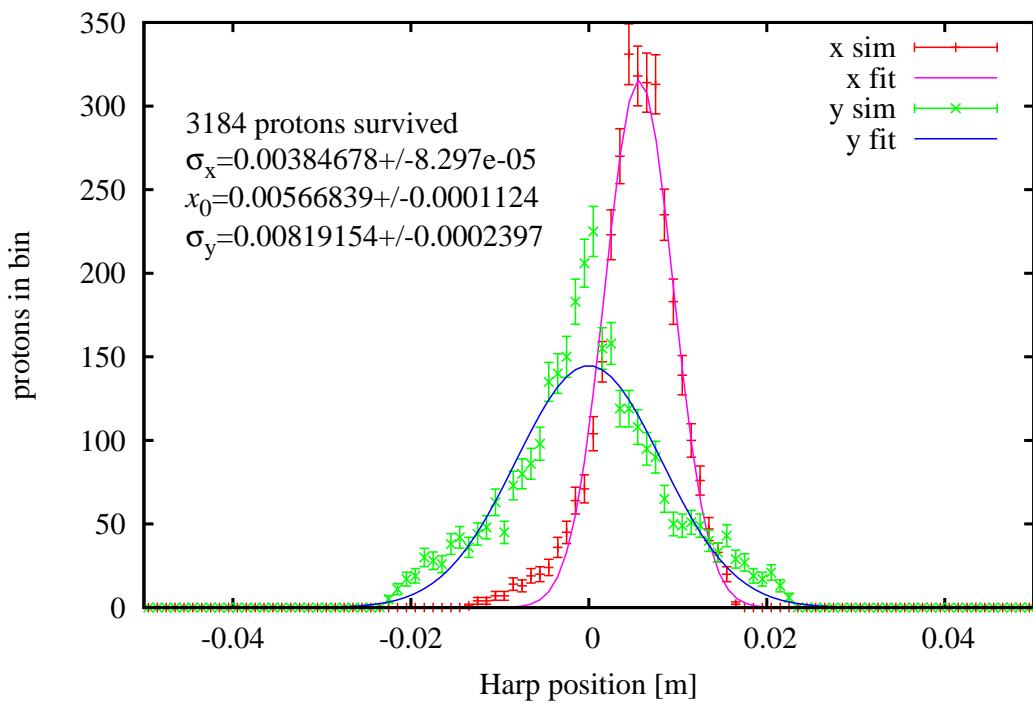
Simulation of injected beam on A15 harp turn 10



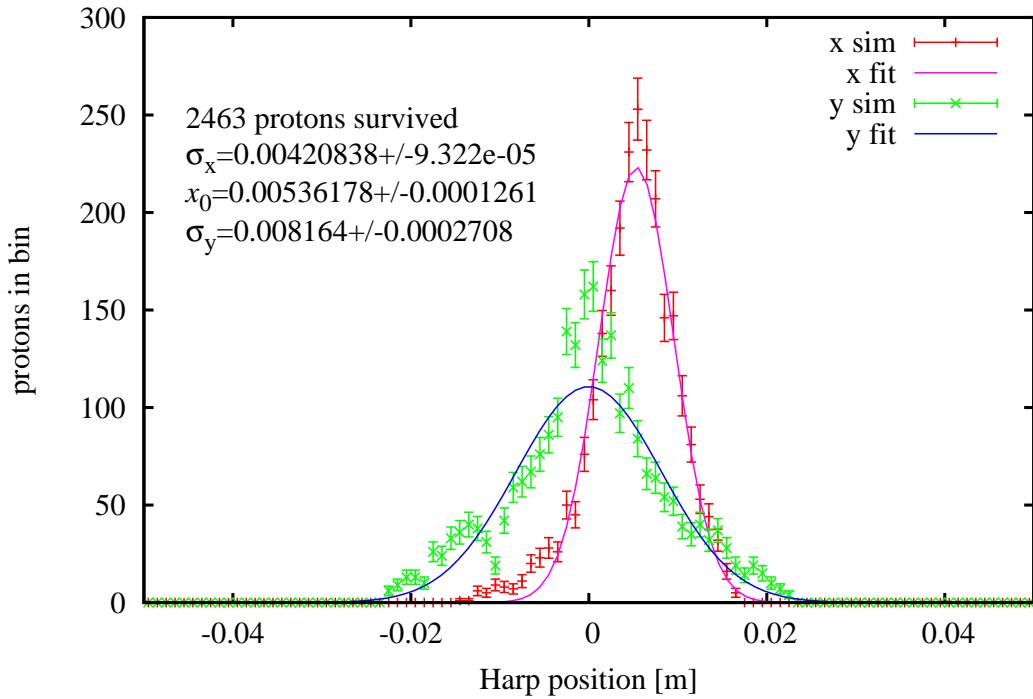
Simulation of injected beam on A15 harp turn 15



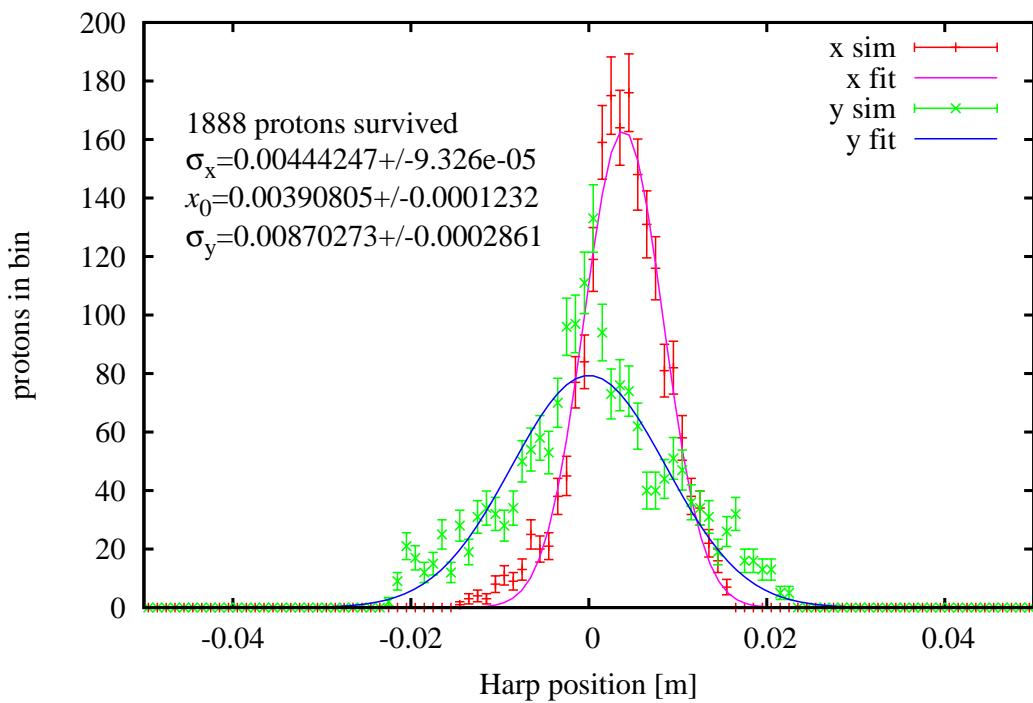
Simulation of injected beam on A15 harp turn 20



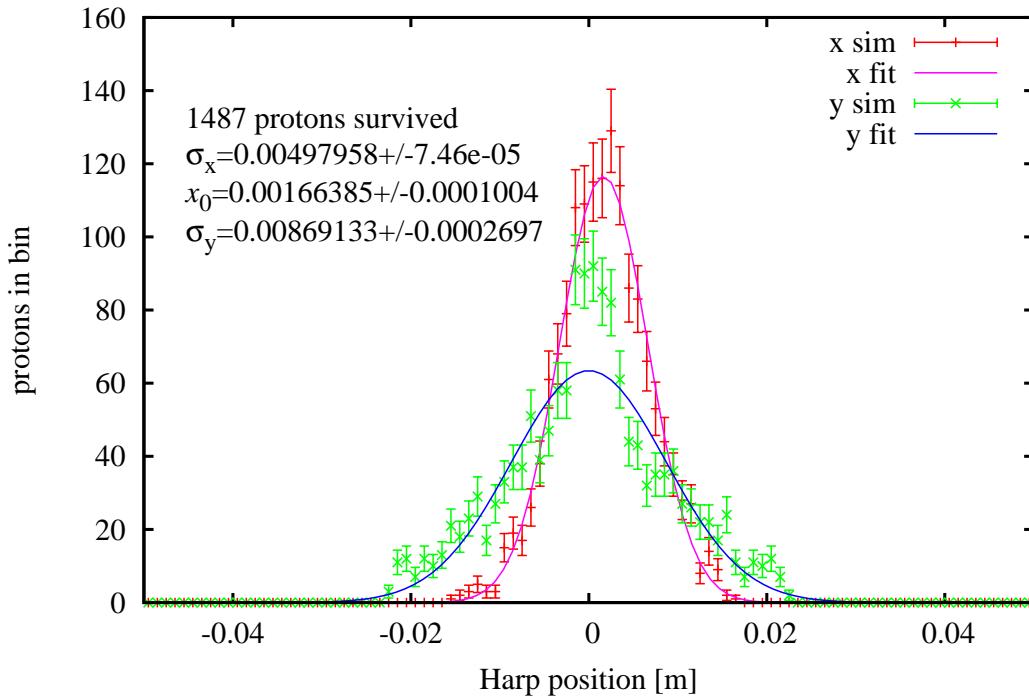
Simulation of injected beam on A15 harp turn 25



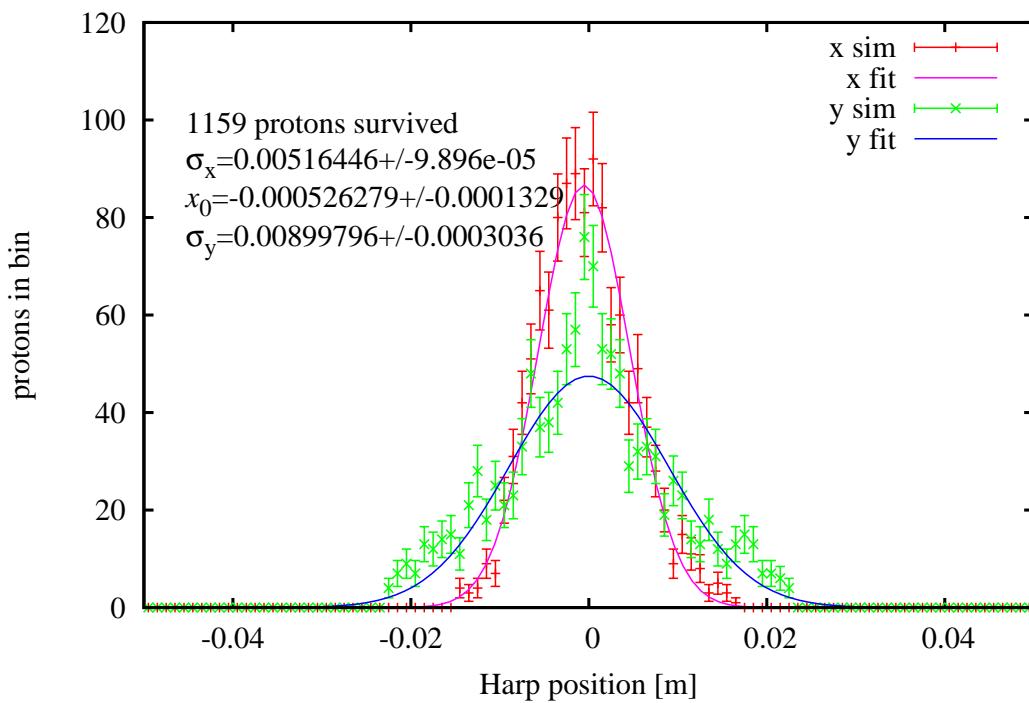
Simulation of injected beam on A15 harp turn 30



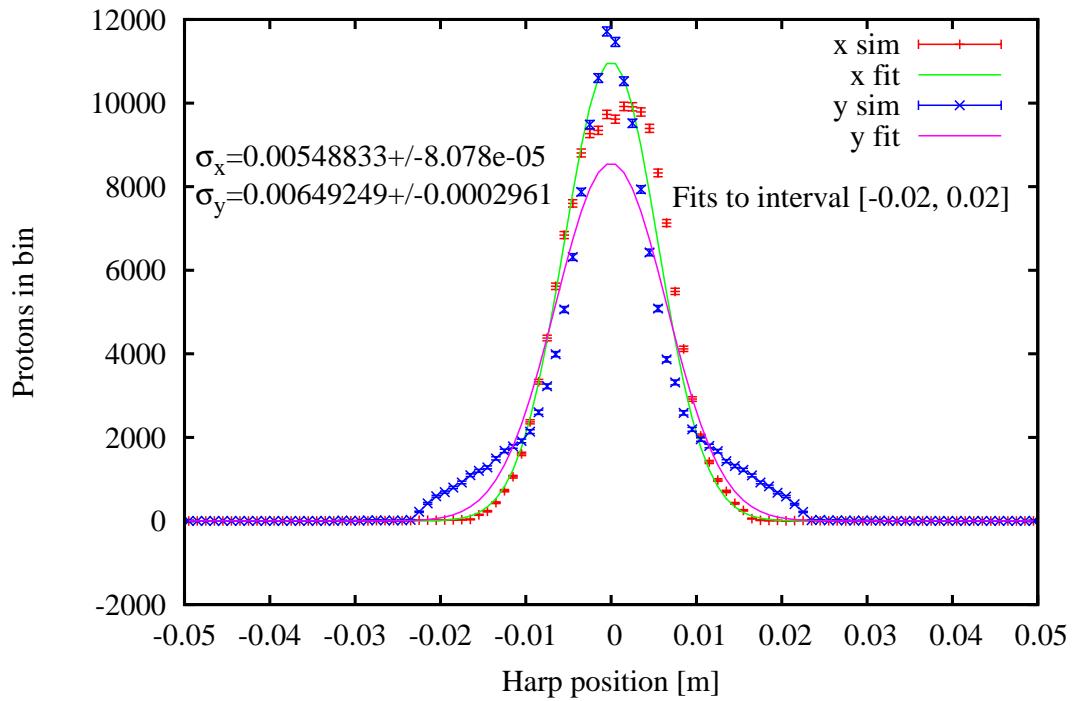
Simulation of injected beam on A15 harp turn 35



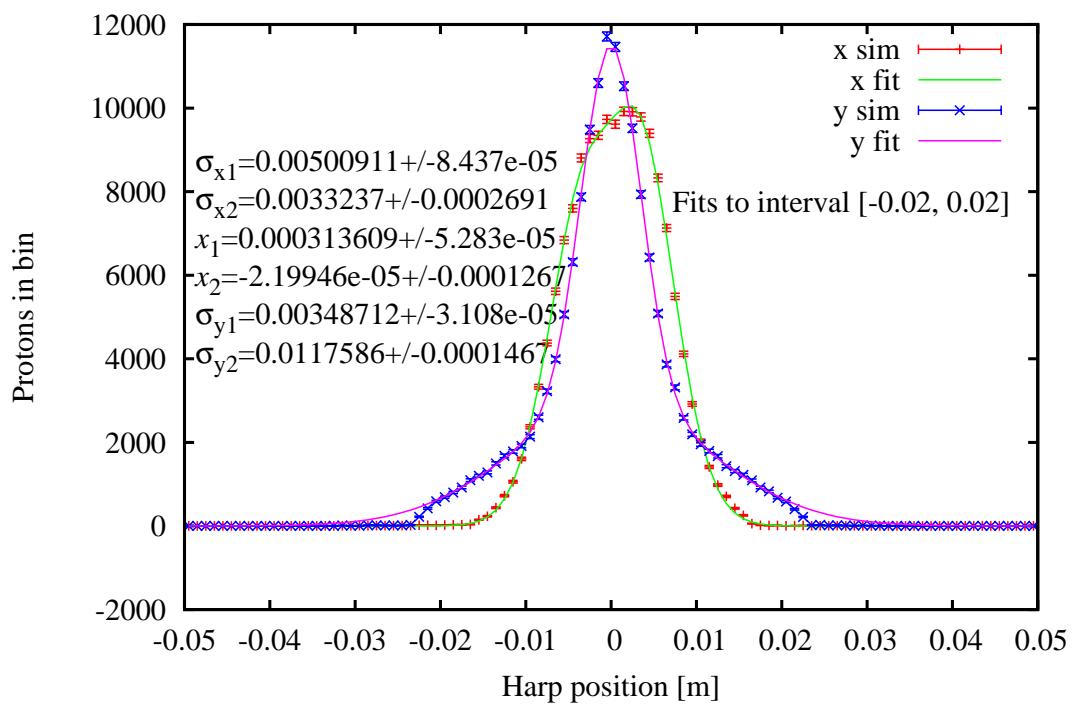
Simulation of injected beam on A15 harp turn 40



Single Gaussian fits: A15 harp integrated over 41 turns



Double Gaussian fits: A15 harp integrated over 41 turns



The double Gaussian fit was to the function

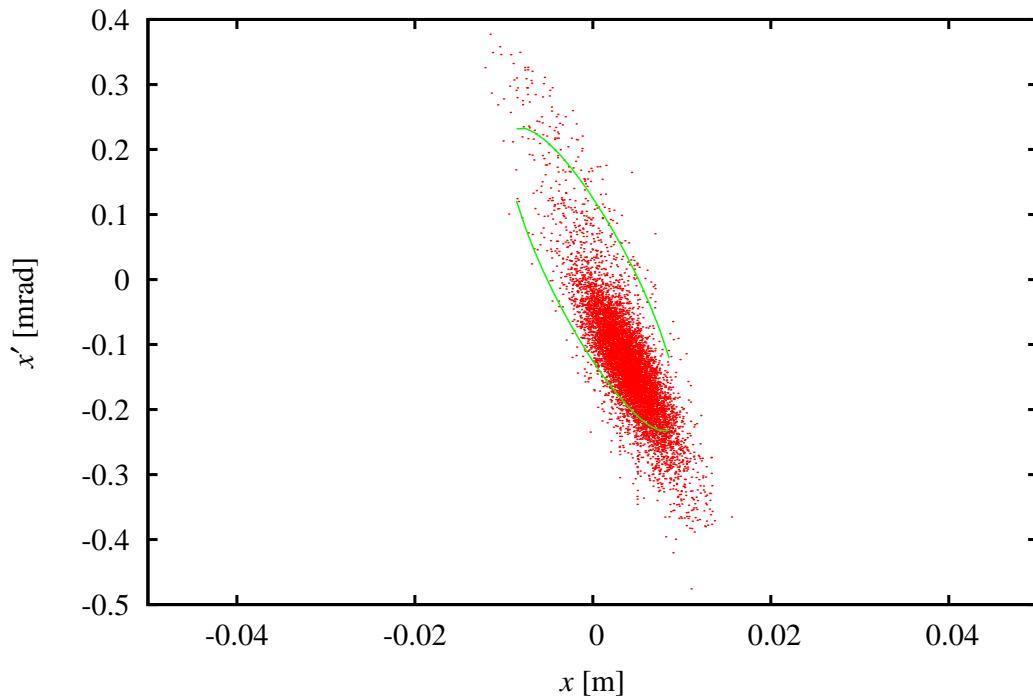
$$f(x) = \frac{N_{x1}}{\sqrt{2\pi} \sigma_{x1}} \exp\left(-\frac{(x - x_1)^2}{2\sigma_{x1}^2}\right) + \frac{N_{x2}}{\sqrt{2\pi} \sigma_{x2}} \exp\left(-\frac{(x - x_2)^2}{2\sigma_{x2}^2}\right),$$

for the x distribution and

$$f(y) = \frac{N_{y1}}{\sqrt{2\pi} \sigma_{y1}} \exp\left(-\frac{y^2}{2\sigma_{y1}^2}\right) + \frac{N_{y2}}{\sqrt{2\pi} \sigma_{y2}} \exp\left(-\frac{y^2}{2\sigma_{y2}^2}\right),$$

for the y distribution.

Phase space distribution after A15 harp turn 40



Phase space distribution after A15 harp turn 40

